Corruption, growth and ethnolinguistic fractionalization: a theoretical model

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Abstract

This paper analyzes the existing relationship between ethnolinguistic fractionalization, corruption and the growth rate of a country. We provide a simple theoretical model. We show that a non–linear relationship between fractionalization and corruption exists: corruption is high in homogeneous or very fragmented countries, but low where fractionalization is intermediate. In fact, when ethnic diversity is intermediate, constituencies act as a check and balance device to limit ethnically-based corruption. Consequently, the relationship between fractionalization and growth rate is also non-linear: growth is high in the middle range of ethnic diversity, low in homogeneous or very fragmented countries.

Keywords: corruption, ethnic fractionalization, economic growth.
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1 Introduction

In recent years, the economic interest in ethnolinguistic fractionalization has increased, in part due to greater cross–border movements. Although ethnic diversity is an omnipresent theme throughout history, economists are only recently starting to pay attention to it. Journalists pay attention to ethnic diversity mostly when it erupts into bloodshed, although ethnic fractionalization does not automatically, nor exclusively, imply ethnic conflict. The recent literature has claimed that cross–country differences in ethnic diversity explain a substantial part of cross–country differences in public policies, political instability and other economic factors associated with long–run growth (see Easterly and Levine 1997). Political economy models suggest that polarized societies will be both prone to competitive rent–seeking by different groups and have difficulty agreeing on public goods like infrastructure, education and good policies (Alesina and Drazen 1991; Slheifer and Vishny 1993; Alesina and Spoloare 1997). Alesina and Drazen (1991) describe how a war of attrition between interest groups can postpone macroeconomic stabilization. Alesina et al. (1999) present a model linking heterogeneity of preferences across ethnic groups in a city to the amount and type of public goods the city supplies. Results show that the shares of spending on productive public goods are inversely related to the city's ethnic fragmentation. Mauro (1995), La Porta et al. (1999) and Alesina et al.[1] (2003), amongst others, show that ethnic fractionalization is negatively correlated with measures of infrastructure quality, literacy and school attainment.

Ethnolinguistic fractionalization appears to be responsible for a variety of corruption–related phenomena (Shleifer and Vishny 1993; Svensson 2000). Svensson (2000) and Mauro (1995) find that corruption is higher the higher ethnic diversity. Svensson (2000) also finds that corruption increases where there is more foreign aid in an ethnically–divided society although this is not the case in an ethnically–homogeneous one. In Shleifer and Vishny (1993) corruption may be particularly damaging when there is more than one bribe-taker. If each independent bribe-taker does not internalize the effects of his bribes on the other bribe-takers' revenues, then the result is more bribes per unit of output and less output. Ethnically–diverse societies may be more likely to yield independent bribe-takers, since each ethnic group have responsibility for a region or ministry in the power structure. For this reason Mauro (1995) regresses growth on corruption assuming an index of ethnolinguistic fractionalization as an instrumental variable to test the hypothesis that more fractionalization (and therefore more corruption)

[1] These results are very strong in regressions without income per capita (which may be endogenous to ethnic fractionalization). They lose some of their significance where on the right hand side one checks for GDP per capita.

is associated with lower economic growth[2].

The literature has thus stressed the negative role of ethnic fragmentation on corruption and thus on economic growth. But alongside this negative role, there is the possibility of a positive role for ethnic diversity. In fact as Alesina and La Ferrara say (2003):

" Is ethnic diversity "good" or "bad" from an economic point of view, and why? Its potential costs are fairly evident. Conflict of preferences, racism, prejudices often lead to policies which are suboptimal from the point of view of society as a whole, and to the oppression of minorities which can explode in war or least in disruptive political instability. But an ethnic mix also brings about variety in abilities, experiences, cultures which may be productive and may lead to innovation and creativity. The United States are the quintessential example of these two faces of racial relations in a "melting pot". "

We contribute to this debate by analyzing how ethnolinguistic fractionalization can influence the extent of corruption.

We stress that this work does not aim at providing policies to reduce corruption or allow growth to increase. We propose a descriptive model since, as Collier (1998) and Alesina et al. (2003) emphasize, it is hard to see any policy implications arising from fractionalization, because there is little that a country can legitimately do about its ethnic composition without affecting other non–economic variables which are not the object of this study.

In our model, we rely on a society populated by bureaucrats, controllers and entrepreneurs, producing a single good. The population is fractionalized in n different ethnic groups. A theoretical game is constructed as follows: the entrepreneur has to choose between the traditional sector and the modern sector. We assume that the modern sector has higher productivity than the traditional sector. In order to enter the modern sector, the entrepreneur has to request a license from the bureaucrat. The bureaucrat can ask the entrepreneur for a bribe in exchange for providing the license. The entrepreneur can accept or refuse to pay the bribe. Moreover, we consider the presence of monitoring activity. Monitoring activity is related to the intervention of the controllers in order to penalize illegal interactions between entrepreneurs and bureaucrats.

In our work, the optimal monitoring level is endogeneously derived. We assume that ethnic fractionalization has two opposite effects: on the one hand, it increases the cost of monitoring but, on the other hand, high ethnic fractionalization generates an increase in the probability of being reported, because the controller reports the corrupt transaction only if the bureaucrat

[2] *"Sociological factors may contribute to rent-seeking behavior. An index of ethnolinguistic fractionalization (societal divisions along ethnic and linguistic lines) has been found to be correlated with corruption. Also, public officials are more likely to do favors for their relatives in societies where family ties are strong".* Mauro (1997)

and/or entrepreneur belong to a different ethnic group from that of the controller. Indeed, for certain levels of ethnic diversity, fragmentation takes on a positive role in controlling corruption because it increases the level of control between different ethnic groups. In this context, we also find a non–linear relationship between ethnic diversity, corruption and growth: in fact homogeneous and fragmented societies are characterized by high corruption and low economic growth. In the middle range of ethnic diversity, the ethnic factor acts as a "control" on corruption producing greater economic growth.

The rest of the paper is organized as follows. In section 2, we present the model and the related theoretical game. In section 3 the relationship between the monitoring level, corruption and economic growth is studied. In section 4, using the results of the previous sections, we endogenize the monitoring level of controllers and we prove that a non-linear relationship between fractionalization - via corruption - and growth exists. Section 5 concludes.

2 The theoretical game model

Let us consider an economy producing a single homogeneous good composed of a continuum of 3 types of agents: bureaucrats, controllers and entrepreneurs. The controllers monitor entrepreneurs' behavior in order to weed out or reduce corruption. Firms manufacture a homogeneous product y using either one of two technologies[3] with constant return to scale: the modern sector technology and the traditional sector technology. Each entrepreneur is assumed to have the same quantity of capital k. The product may either be manufactured for consumption purposes or for investment purposes. The modern sector technology is:

$$y = a_M k \tag{1}$$

In order to obtain their license, the entrepreneurs need to submit a project to the Public Administration. The entrepreneur may access the traditional sector without any license being issued by the Public Administration. In this case the output is:

$$y = a_T k \tag{2}$$

From here on, it will be assumed that $a_M > a_T$ and therefore that the modern sector is more profitable than the traditional sector.

[3]As in Li, Xu and Zou (2000) an agent can produce in either the traditional or the modern sector. Productivity in the modern sector is greater than that in the traditional sector. The advantage of the traditional sector is that it is not subject to expropriation, while that of the modern sector is. The rationale is that entrepreneurs in the modern sector must obtain permits and licenses and are vulnerable to the effects of corruption. This hypothesis could be interpreted by regarding the modern sector as an innovative sector (e.g. telecommunications) which is still in need of State regulation.

The bureaucrat receives a salary w[4]. In this model, the bureaucrat may decide to issue a license only in exchange for a bribe. Since the gross profit resulting from the investment in the modern sector is higher than the one in the traditional sector, the entrepreneur may find it worthwhile to offer a bribe to the corrupt bureaucrat in order to obtain the necessary license to access the modern sector. The bureaucrat will be assumed to enjoy monopolistic power (i.e. he is the only one who may issue the required license) and discretionary power (i.e. he may refuse to issue the license with no need to provide any reasons or explanations) in granting the license. The bureaucrat may decide not to ask for a bribe and to issue the license to all those who submit a project, or he may decide to ask for a bribe in exchange for such a license. The State monitors entrepreneurs – via controllers – in such a way that q_i is the probability that the entrepreneur belonging to the i-th ethnic group is reported. In our model, we assume that only the entrepreneur detected in a corrupt transaction will be punished. The entrepreneurs are not homogeneous agents and they incur a different reputation cost. More precisely, the j-th entrepreneur attributes a subjective value $c_j k$ to the objective punishment when the corrupt transaction is detected,[5] where $c_j \in [0, 1]$.

The controller must monitor the entrepreneur's behavior. Every controller puts a level of monitoring m in place and only if he meets a corrupt entrepreneur belonging to a different ethnic group will he report the corruption[6]. We hypothesize that "The Department of Controllers" is divided in proportion to ethnic groups[7]. Let $\omega_i \in [0, 1]$ the probability that an individual belongs to the i-th ethnic group, with $i = 1, \ldots n$. In our model we rely on a country where the different ethnic groups are the same

[4]It is assumed that no arbitrage is possible between the public and the private sector and that therefore there is no possibility of the bureaucrats becoming entrepreneurs, even if their salary w were lower than the entrepreneur's net return. This happens because the bureaucrat individuals in the population have no access to the capital markets, but only a job, and therefore may not become entrepreneurs.

[5]The punishment for the entrepreneur is not a constant, but rather a function of the investment. In this case, based on the statements of Rose - Ackerman (1999): *"On the other side of the corrupt transaction, a fixed penalty levied on bribers will lower both the demand for corrupt services and the level of bribes. However, it will have no marginal impact once the briber passes the corruption threshold. To have a marginal effect, the penalties imposed on bribe payers should be tied to their gains (their excess profits, for example)".* pp. 55. The punishment for the entrepreneur is considered as a function of the investment determining the size of the profits.

[6]Early work on social identity theory has established that patterns of intergroup behavior can be understood considering that individuals may attribute positive utility to the well–being of members of their own group and negative utility to that of members of others group (see e.g. Tajfel et al. 1971).

[7]Notice that our model does not apply if ethnic fractionalization is not reflected also in institutions, as it is often the case in dictatorships.

size. Therefore

$$\omega_i = \omega = \frac{1}{n}. \tag{3}$$

The controller earns αm from the State for the monitoring level m and he encounters increasing difficulty in monitoring entrepreneurs as the number of ethnic groups grows. The optimal monitoring level m will be derived endogenously in the model and it will be a non linear function of ethnolinguistic fractionalization n. In the rest of the paper we refer to the entrepreneur payoff by a superscript (E) and to the bureaucrat payoff by a superscript (B).

Our model can be formalized by introducing the following three-period dynamic game:

(1) At stage one of the game, the entrepreneur should decide in which sector to invest, i.e. whether to invest his capital in the modern or in the traditional sector. Such a decision is tantamount to the decision of whether to submit the project to the Public Administration, considering that a license is needed to invest in the modern sector. Project submission does not result in the automatic issue of the license by the bureaucrat, in that the bureaucrat may refuse to grant the license unless a bribe b is paid.

   (1.1) If the entrepreneur decides not to submit the project (investing in the traditional sector) the game ends and then the payoff vector for bureaucrat and entrepreneur is:

$$\underline{\pi}_1 = (\pi_1^{(B)}, \pi_1^{(E)}) = (w, a_T k). \tag{4}$$

   (1.2) If the entrepreneur decides to submit the project, he asks the bureaucrat to issue the license. In this case the game continues to stage two.

(2) At stage two the bureaucrat decides[8] the amount to ask for as a bribe b^d for issuing the license.

   (2.1) If the bureaucrat, facing an entrepreneur who has submitted a project, decides not to ask for a bribe ($b^d = 0$) for issuing the license, then the game ends and the payoff vector for bureaucrat and entrepreneur is:

$$\underline{\pi}_2 = (\pi_2^{(B)}, \pi_2^{(E)}) = (w, a_M k). \tag{5}$$

   (2.2) If the bureaucrat decides to negotiate the payment of a bribe ($b^d > 0$) with the entrepreneur in order to obtain the license, the game continues to stage three.

[8]The bureaucrats, if indifferent as to whether to ask for a bribe or not, will prefer to be honest.

(3) At stage three, the entrepreneur should decide whether to negotiate the bribe to be paid to the bureaucrat or to refuse to pay the bribe. Should he decide to enter into negotiation with the bureaucrat, the two parties will find the bribe corresponding to the Nash solution to a bargaining game b^{NB} and the game ends. The payoffs will depend on whether the i-th entrepreneur is reported (with probability q_i) or not.

(3.1) If the entrepreneur refuses the bribe, then the payoff vector is given by

$$\underline{\pi}_3 = (\pi_3^{(B)}, \pi_3^{(E)}) = (w, a_T k). \tag{6}$$

Then the game ends.

(3.2) Otherwise the negotiation starts. Let b^{NB} be the final equilibrium bribe then, given the probability level q_i, the expected payoff vector is:

$$\underline{\pi}_4 = (\pi_4^{(B)}, \pi_4^{(E)}) = \big(w + (1-q_i)b^{NB}, a_M k - (1-q_i)b^{NB} - q_i c_j k\big) \tag{7}$$

The game ends.

It should be noted that in this model $\underline{\pi}_2$ is preferred to $\underline{\pi}_3$ by both agents, and therefore the bureaucrat will never ask for a bribe which he knows that the entrepreneur would turn down. When a controller monitors a corrupt transaction, he decides to charge for it only if the entrepreneur belongs to a different ethnic group from that of the controller. The probability of a controller, belonging to the i-th ethnic group, meeting an entrepreneur belonging to the i-th ethnic group as well, will be equal to $\frac{1}{n}$. Then q_i is the probability of the entrepreneur belonging to the i-th ethnic group being reported and it derives from the probability of being monitored (m) and from the probability of the controller belonging to an ethnic group different from i. Then

$$q_i = q = m\left(1 - \frac{1}{n}\right), \qquad \forall\, i = 1, \dots, n. \tag{8}$$

The optimum level of m derives from maximization by the controller of his own expected payoff (see paragraph 4).

3 The solution of the game

This game may be solved by backward induction, starting from the last stage of the game. The bribe resulting as the Nash solution to a bargaining game in the last subgame should be determined. This bribe is the outcome of a negotiation between the bureaucrat and the entrepreneur, who will be assumed to share a given surplus on an equal basis. We first determine the equilibrium bribe (b^{NB}) (see Appendix A for the proof).

Proposition 3.1. *Let $q \neq 1$.*[9] *Then there exists a unique non negative bribe b_j^{NB}, as the Nash solution to a bargaining game, given by:*

$$b_j^{NB} = \left[\frac{(a_M - a_T)k - qc_j k}{2(1-q)} \right]. \tag{9}$$

Proposition 3.1 shows that, when the equilibrium is reached, the entrepreneur gives half of the surplus to the bureaucrat, such a surplus being the difference in the expected return on the investment in the two different sectors (modern and traditional), net of the entrepreneur's expected costs for being detected in a corrupt transaction.

Remark 3.2. *We notice that a straightforward computation gives that the equilibrium bribe b_j^{NB} is increasing with respect to the probability of being detected in a corrupted transaction. Therefore, increasing q, reduces the potential surplus that the bureaucrat and entrepreneur can share, thus reducing the bribe.*

3.1 The static equilibrium

The game has been solved in Appendix B by using the backward induction method starting from the last stage of the game. Its solution is formalized by the following proposition.

Proposition 3.3. *Let $0 \leq \frac{(a_M - a_T)}{q} = c^\circ \leq 0$. Then,*

(a) If $c_j \in [0, c^\circ]$ then the equilibrium payoff vector is:

$$\underline{\pi}_4 = \left(w + \frac{(a_M - a_T)k}{2} - \frac{c_j kq}{2}, \frac{(a_M + a_T)k}{2} - \frac{c_j kq}{2} \right) \tag{10}$$

*this is the payoff vector connected to equilibrium **C** (see below);*

(b) if $c_j \in (c^\circ, 1]$ then the equilibrium payoff vector is:

$$\underline{\pi}_2 = (w, a_M k) \tag{11}$$

*this is the payoff vector connected to equilibrium **NC** (see below).*

The previous proposition shows that we obtain two perfect Nash equilibria in the sub-games, depending on the parameter values:

- Equilibrium **C**: if $c_j \leq c^\circ$, the difference in gross profits between the modern sector and the traditional sector is such as to make up for the expected cost of corruption. Thus, the surplus to be shared between the entrepreneur and the bureaucrat will keep a negotiation going, the outcome of wich is the bribe corresponding to the Nash solution to a bargaining game;

[9] If $q = 1$ this stage of the game is never reached.

- Equilibrium **NC**: if $c_j > c^\circ$, i.e. the "shame cost" is so high that the entrepreneur would turn down a request for a bribe. Realising this fact, the bureaucrat will refrain from asking for a bribe for issuing the license. Thus the entrepreneur will enter the modern sector and will not be asked for a bribe by the bureaucrat.

There are two ranges of c_j which correspond to different corruption levels: in fact, in equilibrium **C** corruption is widespread, while it is absent in equilibrium **NC**.
As we said, our model assumes that reputation costs may vary across different entrepreneurs (c_j for the j–th entrepreneur), reflecting different individual ethical, moral and religious values or denoting a greater or lesser sense of their own impunity. In fact, the j-th entrepreneur attributes a subjective value to the objective punishment – depending on his own "shame effect" – when the corrupt transaction is detected. This argument applies to each ethnic group.
The cumulative density of probability, defines the distribution of individual costs $F(c_j)$, where j is the specific entrepreneur. This function represents the fraction of entrepreneurs who agree to be corrupted when ethnolinguistic fractionalization is n. We assume that the distribution of entrepreneurs' costs is of the Kumaraswamy type with real parameters α_1 and α_2. This choice is reasonable, because the shape of the Kumaraswamy density function changes as the values of α_1 and α_2 vary[10]. Therefore, this probability law is suitable for describing different types of entrepreneurs' ethical behaviors. More specifically, if $1 < \alpha_2 < \alpha_1$, then the shape of the distribution function is asymmetric to the right, describing entrepreneurs with a high shame effect. Conversely, when $1 < \alpha_1 < \alpha_2$, then we have asymmetry to the left, and the entrepreneurs have a low shame effect.
The cumulative density function for the costs is:

$$F(c_j) = \int_0^{c_j} \alpha_1 \cdot \alpha_2 c^{\alpha_1 - 1}(1 - c^{\alpha_1 - 1})^{\alpha_2 - 1} dc = 1 - (1 - c_j^{\alpha_1})^{\alpha_2}. \tag{12}$$

Given the heterogeneity of entrepreneurs, their behavior will be influenced by their own reputation cost c_j.

In this hypothesis the j-th entrepreneur has a different reputation cost c_j and, then,

$$F(c^\circ) = 1 - (1 - (c^\circ)^{\alpha_1})^{\alpha_2} = 1 - \left(1 - \left(\frac{a_M - a_T}{q}\right)^{\alpha_1}\right)^{\alpha_2} \tag{13}$$

is the fraction of entrepreneurs belonging to the i-th ethnic group with a reputation cost $c_j \leq c^\circ$.

$$1 - F(c^\circ) = (1 - (c^\circ)^{\alpha_1})^{\alpha_2} = \left(1 - \left(\frac{a_M - a_T}{q}\right)^{\alpha_1}\right)^{\alpha_2} \tag{14}$$

[10] We also point out that if $\alpha_1 = \alpha_2 = 1$, then the Kumaraswamy distribution reduces to the uniform distribution.

is the fraction of entrepreneurs belonging to the i-th ethnic group with a reputation cost $c_j > c^\circ$.
Differently with respect to the static case, in a dynamic context, as we will see in the next section, corruption influences the accumulation of capital by entrepreneurs, and thus economic growth.

3.2 Dynamic equilibrium

The game perspective is now expanded to review the dynamic consequences of corruption on growth and, therefore, on investment, while analyzing the entrepreneur's behavior in this respect. As noted, a manufactured product may be either consumed C or invested $\dot{k}$. We consider a simple constant elasticity utility function:

$$U = \frac{C^{1-\sigma} - 1}{1 - \sigma} \tag{15}$$

Each entrepreneur maximizes utility over an infinite period of time subject to a budget constraint. This problem is formalized as:

$$\max_{C \in \Re^+} \int_0^\infty e^{-\rho t} U(C) dt \tag{16}$$

sub

$$\dot{k} = \Pi_E - C, \tag{17}$$

where C is consumption, ρ is the discount rate in time and Π_E is the return on the investment for the entrepreneur.

Since Π_E is different across equilibria, the problem is solved for the two cases[11].

This model predicts that the j-th entrepreneur belonging to the i-th ethnic group will have only one optimum equilibrium – and only one corresponding growth rate – depending on his own reputation cost.

- The entrepreneur with a reputation cost $c_j \leq c^\circ$, will find it worthwhile to be corrupted and then the optimal equilibrium will be **C**. In this equilibrium, the entrepreneur will obtain a consumption growth rate equal to:

$$\gamma_j^C = \frac{1}{\sigma} \left[\frac{a_M + a_T}{2} - \frac{q c_j}{2} - \rho \right]. \tag{18}$$

- The entrepreneur with a reputation cost $c_j > c^\circ$, will find it worthwhile to be honest and then, the optimal equilibrium will be **NC**. In this equilibrium, the entrepreneur will obtain a constant consumption growth rate equal to:

$$\gamma^{NC} = \frac{1}{\sigma} [a_M - \rho]. \tag{19}$$

[11] In the interest of brevity, we report the computation of the growth rate in Appendix D.

Furthermore, it can easily be demonstrated that capital and income also have the same growth rate[12].

Then, at aggregate level, we obtain a income growth rate (γ) weighting over different growth rates for corresponding entrepreneurs. Then, in the equilibrium **C**, there will be $F(c^\circ)$ corrupted entrepreneurs, each with his own growth rate γ_j^C; in the equilibrium **NC** there will be $[1 - F(c^\circ)]$ honest entrepreneurs, all with the same growth rate γ^{NC}. At the aggregate level, we have:

$$\gamma = \frac{1}{\sigma} \cdot [1 - (1 - (c^\circ)^{\alpha_1})^{\alpha_2}] \left[\frac{a_M + a_T}{2} - \rho \right] - \frac{1}{2\sigma} \left[q \int_0^{c^\circ} c dc \right] +$$

$$+ \frac{1}{\sigma} \cdot [1 - (c^\circ)^{\alpha_1}]^{\alpha_2} (a_M - \rho) =$$

$$= \frac{1}{\sigma} \cdot [1 - (c^\circ)^{\alpha_1}]^{\alpha_2} \left(\frac{3a_M}{2} + a_T \right) - \frac{1}{\sigma} \left(\frac{a_M + a_T}{2} - \rho \right) - \frac{q}{4\sigma} \cdot (c^\circ)^2. \quad (20)$$

By substituting $c^\circ = \frac{a_M - a_T}{q}$ into (20), we obtain the economy's growth rate as

$$\gamma = \frac{1}{\sigma} \cdot \left[1 - \left(\frac{a_M - a_T}{q} \right)^{\alpha_1} \right]^{\alpha_2} \cdot \left(\frac{3a_M}{2} + a_T \right) -$$

$$- \frac{1}{\sigma} \left(\frac{a_M + a_T}{2} - \rho \right) - \frac{1}{4\sigma} \cdot \frac{(a_M - a_T)^2}{q}. \quad (21)$$

A straightforward computation gives that $\frac{\partial \gamma}{\partial q} > 0$. This means that the growth rate of the economy increases as the probability of being reported grows. In the next section we will show how this relationship works, by considering an endogeneous optimal monitoring level.

4 Endogenous monitoring

As we said, q is the probability of being reported and it derives from the probability m of being monitored and from the probability $1 - 1/n$ of the entrepreneur belonging to a different ethnic group from that of the controller (see formula (8)).

So far, we have taken monitoring level m as exogenous, but now we make the analysis more realistic, considering that the monitoring level set by the controller results from maximization of his payoff V_m:

$$V_m = \alpha m - C(n, m). \quad (22)$$

where αm are the benefits of a certain monitoring level m for the controller and $C(n, m)$ are monitoring costs, dependent on n and m.

[12]See Appendix E for the proof.

The optimum level of m, named m^*, is derived by maximization of the controller's expected payoff function.
The controller decides the optimal level of monitoring m^* comparing the marginal benefit (α) of a certain monitoring level with the cost of doing it. We state some assumptions about the cost function: costs are assumed to be null in the case of absence of monitoring, as it naturally should be. Moreover, we assume that the marginal costs increase as the monitoring level increases. In fact, comprehensive monitoring activity implies increased costs, since it requires more sophisticated action and specialized knowledge about complex corrupted transactions. As a further requirement, we hypothesize that the costs related to a fixed monitoring level grow as the ethnolinguistic fractionalization n grows. This assumption is driven by the growing complexity of managing and controlling a large number of ethnic groups, implying more difficult (and expensive) monitoring activity.
We compound the remarks and the assumptions stated above, and we define the costs by introducing the Orlicz functions[13]:

$$C(n, m) = g(n)M(m), \tag{23}$$

where:

- $g : \mathbf{N} \to [0, +\infty)$ describes how monitoring level cost depends on the number of ethnic groups. We point out that, in our analysis, the trivial case of a single ethnic group is not considered, and the population is made up of at least two different ethnic groups. We can assume that we know the value of g in the case of two different ethnic groups, with value $g_2 > 0$. Function g is also assumed to be increasing;

- M has support in $[0, 1]$, $M([0, 1]) \equiv [0, \bar{H}]$, $\bar{H} \in \mathbf{R}^+$ and M is a truncation of an Orlicz function as follows:

  $$M(x) := \mathbf{1}_{\{x \in [0,1]\}} \cdot \Gamma(x),$$

  where $\mathbf{1}_A$ is the usual characteristic function of the set A and $\Gamma(x)$ is an Orlicz function such that $\Gamma(1) \equiv M(1) = \bar{H}$. We assume that the kernel function of Γ, named h, is strictly increasing.

The highest monitoring level is attained for $m = 1$. In this case the cost function is:

$$C(n, 1) = g(n)\bar{H},$$

and it depends on the ethnolinguistic fractionalization within the country in that it depends on the term $g(n)$.
The function V_m of the monitoring activity, for the controller, is maximized

[13]For the concept of Orlicz functions and kernels, see Appendix F.

for an optimal monitoring level m^*, which can be found by imposing the first order condition:

$$\frac{\partial V_m}{\partial m} = \alpha - g(n)h(m^*) = 0.$$

Since h is strictly increasing, then there exists the inverse function h^{-1}. We assume hereafter the following condition for the weights $g(n)$.

$$\forall n \in \mathbf{N} \Rightarrow g(n) \geq \alpha h(1). \tag{24}$$

Condition (24) states that the cost adjustment factor $g(n)$ is not less than a certain threshold depending on the monitoring costs and the marginal benefit of monitoring.
By imposing (24), we can find the optimal monitoring level $m^* \in [0, 1]$ given by:

$$m^* = h^{-1}\left(\frac{\alpha}{g(n)}\right). \tag{25}$$

By considering the continuous version of the function $g : [0, +\infty) \to [0, +\infty)$, assuming that g is differentiable and replacing the discrete variable n with the continuous variable x, we can compute the first derivative of m^*,

$$(m^*)'(x) = \frac{1}{h'(\alpha/g(x))} \cdot \frac{-\alpha g'(x)}{g^2(x)} < 0, \tag{26}$$

since g is increasing respect to n.

Thus, the assumption that g is increasing implies that the optimal monitoring level decreases as the number of ethnic groups grows. This is due to the fact that the monitoring costs grow as the number of ethnic groups increases.

By substituting the optimal m^* of (25) into (8), we find the optimal probability of being reported q^*:

$$q^* = h^{-1}\left(\frac{\alpha}{g(n)}\right) \cdot \left(1 - \frac{1}{n}\right). \tag{27}$$

Then the optimal probability of being reported q^* depends on ethnolinguistic fractionalization through two channels:

(1) the optimal monitoring level: as ethnic diversity increases, we have shown that the monitoring cost also increases and thus the optimal monitoring level m^* declines;

(2) the probability of the entrepreneur belonging to a different ethnic group from that of the controller: as the number of ethnic groups increases, the probability of the entrepreneur belonging to the same ethnic group decreases. Therefore the probability of the entrepreneur belonging to a different ethnic group from that of the controller increases.

More intuitively, on the one hand as ethnic diversity increases, the monitoring cost increases and then the optimal monitoring level decreases, thus optimal q^* decreases. On the other hand, as ethnic diversity increases, the probability of the entrepreneur belonging to a different ethnic group from that of the controller increases. Uniting these two opposite channels we will show (see theorem 4.1.) that there is a threshold value of ethnic diversity n^* where the probability of being reported reaches a maximum. For lower fractionalization levels, i.e. before n^*, the probability of being reported q^* increases with respect to ethnic diversity n. Indeed, the increase in the probability of being reported – due to the fact that the bureaucrat and/or entrepreneur belong to a different ethnic group from that of the controller – overtakes the reduction in monitoring level – due to the increasing monitoring cost –. For high fractionalization levels, i.e. after n^*, the growing monitoring costs overtake the increase in the probability of being reported.
These results are reflected in the aggregate growth rate. We define by γ^* the growth rate computed at the optimal monitoring level m^* (and so at the optimal level q^*) by substituting (27) and (25) into (20) as follows:

$$\gamma^* = \frac{1}{\sigma} \cdot \left[1 - \left(\frac{a_M - a_T}{q^*}\right)^{\alpha_1}\right]^{\alpha_2} \cdot \left(\frac{3a_M}{2} + a_T\right) -$$

$$-\frac{1}{\sigma}\left(\frac{a_M + a_T}{2} - \rho\right) - \frac{1}{4\sigma} \cdot \frac{(a_M - a_T)^2}{q^*}. \tag{28}$$

We measure the corruption level with the fraction of corrupted entrepreneurs, given by (13). By substituting (27) into (13), we have:

$$F(c^\circ)^* = 1 - \left(1 - \left(\frac{a_M - a_T}{q^*}\right)^{\alpha_1}\right)^{\alpha_2}. \tag{29}$$

This formula shows that, before n^*, as ethnic diversity increases, corruption – via increasing probability of being reported q^* – decreases; conversely, after n^* as ethnic diversity increases, corruption also increases, due to the decreasing probability of being reported q^*.

In the next result, the previous arguments are formalized:

Theorem 4.1. *Assume that there exists $n^* \in \mathbf{N}$ such that*

$$g(n^*) = \alpha h\left(\frac{n^*}{K(n^* - 1)}\right), \tag{30}$$

with

$$K = \frac{2}{h^{-1}(g_2/\alpha)}. \tag{31}$$

Moreover, assume that

$$\begin{cases} g(n) < \alpha h\left(\frac{n^*}{K(n^*-1)}\right) & \text{for } n > n^*; \\ g(n) > \alpha h\left(\frac{n^*}{K(n^*-1)}\right) & \text{for } n < n^*. \end{cases} \tag{32}$$

Then n^* is the unique absolute maximum point for q^* and for γ^*, and it is the unique minimum point for (c°).

For the proof see Appendix G.

In Theorem 4.1, we showed that ethnolinguistic diversity increases the monitoring activity level, up to a critical ethnolinguistic threshold n^*. In this case, the growth rate increases and the corruption level declines. For high fractionalization levels, i.e. after n^*, the growing monitoring costs reduce the monitoring level and thus economic growth.

Moreover, the dynamic analysis shows a U-curve between ethnolinguistic fractionalization and the growth rate. Indeed, we showed that, in the case of very fragmented countries or, conversely, in a homogeneous society, the economy has a low growth rate and widespread corruption, while in intermediate fragmented countries, the economy has a high growth rate and limited corruption.

5 Conclusion

In this work, we have analyzed the influence of cultural and ethnic factors on the spread of corruption. The theoretical and empirical literature has stressed how greater ethnolinguistic fractionalization can produce greater corruption; in our model, on the other hand, we have shown that intermediate ethnolinguistic fractionalization makes the control system more incisive on the bureaucrat's behavior, and thus might reduce corruption.

A theoretical game model is presented, in order to explore the relationship between ethnolinguistic fractionalization, corruption and the growth rate. Very general conditions on the model's parameters are assumed. In particular, we state that the reputation costs follow a Kumaraswamy distribution, which belongs to the family of two–parameter distribution but, differently from the Beta law, it is explicitly tractable from a mathematical point of view.

We find an ethnolinguistic threshold n^* such that before n^* the growth rate grows and the corruption level declines. For higher fractionalization levels, i.e. after n^*, the growing monitoring costs drive growing corruption and a low economic growth and monitoring level.

The dynamic analysis shows a U-curve between ethnolinguistic fractionalization and the growth rate: in the case of a high level of n or, conversely, in a homogeneous society, the economy has a low growth rate, while in the middle of the range of ethnic diversity, the economy has a high growth rate and limited corruption.

A Appendix

Let $\underline{\pi}_\Delta = \underline{\pi}_4 - \underline{\pi}_3 = (\pi_\Delta^{(E)}, \pi_\Delta^{(B)})$ be the vector of the differences in the payoffs where $\underline{\pi}_4$ is the agreement about the bribe and where $\underline{\pi}_3$ is disagreement between bureaucrat and entrepreneur. The bribe b^{NB} associated to the Nash solution to a bargaining game is the solution of the following maximum problem

$$\max_{b \in \Re^+} (\pi_\Delta^{(E)} \cdot \pi_\Delta^{(B)}), \tag{33}$$

i.e.

$$\max_{b \in \Re^+} \left\{ [a_M k - (1-q)b - qc_j k - a_T k] \cdot [w + (1-q)b - w] \right\}, \tag{34}$$

that is the maximum of the product between the elements of $\underline{\pi}_\Delta$ and where $[a_T k, w]$ is the point of disagreement, i.e. the payoffs that the entrepreneur and the bureaucrat respectively would obtain if they did not come to an agreement. Since the objective function is concave with respect to b, a sufficient condition for b being a maximum is the first order condition

$$\frac{\partial \left(\pi_\Delta^{(E)} \cdot \pi_\Delta^{(B)} \right)}{\partial b} = 0 \Rightarrow$$

$$(a_M - a_T)k(1-q) - c_j(1-q)k - 2b(1-q)^2 = 0 \Rightarrow$$
$$2b(1-q)^2 = (a_M - a_T)k(1-q) - c_j(1-q)k \Rightarrow$$
$$b^{NB} = \left[\frac{(a_M - a_T)k - c_j kq}{2(1-q)} \right] \tag{35}$$

that is the unique equilibrium bribe in the last subgame, $\forall q \neq 1$.

B Appendix

The static game is solved with the backward induction method. Starting from stage 3, the entrepreneur needs to decide whether to negotiate with the bureaucrat. Both payoffs are then compared, because the bureaucrat asked for a bribe.

(3) At stage three the entrepreneur negotiates the bribe if and only if

$$\pi_4^{(E)} > \pi_3^{(E)} \Rightarrow (a_M)k - (1-q)b^{NB} - c_j kq > a_T k \tag{36}$$

i.e. the entrepreneur payoff negotiated is greater than his payoff in the case of refusal. Since under a perfect information hypothesis, the entrepreneur knows the final equilibrium bribe b^{NB} then we substitute this value in the previous inequality and, by simplification, we obtain

$$\frac{(a_M + a_T)k}{2} - \frac{c_j kq}{2} > a_T k \Rightarrow$$

$$\frac{(a_M - a_T)k}{2} - \frac{c_j kq}{2} > 0 \tag{37}$$

that is verified $\forall q \leq \frac{a_M - a_T}{c_j q} = q^\circ$.

Notice that in order to have an admissible probability set, q must belong to $[0, 1]$. Since $a_M > a_T$, then we have

$$q^\circ = \frac{a_M - a_T}{qc_j} \geq 0. \tag{38}$$

Moreover, if the entrepreneur's surplus in investing in the modern sector rather than in the traditional one is smaller than the expected reputation costs, then we have

$$q^\circ = \frac{a_M - a_T}{qc_j} \leq 1.$$

Conversely, if the profitability of investing in the modern sector is greater than the expected reputation costs, then $q^\circ > 1$ and the entrepreneur is corrupted, independently of the value of q. We assume that $q^\circ = \frac{a_M - a_T}{qc_j} \leq 1$. Generally, if $q \leq q^\circ$ the entrepreneur negotiates the bribe, while if $q > q^\circ$ he refuses the bribe.

(2) Going up the decision–making tree, at stage two the bureaucrat decides whether to ask for a bribe.

• Let $q > q^\circ$ then the bureaucrat knows that the entrepreneur will not accept any bribe so he will be honest and he will pursue the license without any bribe.

• Let $q \leq q^\circ$ then the bureaucrat knows that if he asks for a bribe then the entrepreneur will enter into negotiation and the final bribe will be b^{NB}. Then at stage two the bureaucrat asks for a bribe if and only if

$$\pi_4^{(B)} > \pi_2^{(B)} \Rightarrow w + (1-q)b^{NB} - qc_j k > w$$

i.e. the bureaucrat payoff if asking for a bribe is greater than his payoff if he does not ask for a bribe. By substituting b^{NB} in the previous inequality and simplifying the previous inequality, we obtain

$$a_M - a_T > c_j q$$

that holds $\forall q \geq q^\circ$. So we can conclude that if $q \leq q^\circ$ then the bureaucrat asks for the bribe b^{NB} and the entrepreneur accepts.

(1) At stage one the entrepreneur has to decide whether to submit the project.

• Let $q > q^\circ$ then the entrepreneur knows that if he submits a project no bribe will be asked for. So he will submit the project if and only if

$$\pi_2^{(E)} > \pi_1^{(E)} \Rightarrow a_M < a_T$$

The previous inequality is always verified by hypothesis.

• Let $q \leq q^\circ$ then the entrepreneur knows that the bureaucrat will ask for the bribe b^{NB} which he will accept. So, at stage one, he has to decide whether to invest in the modern sector. He will not invest in the modern sector if and only if

$$\pi_1^{(E)} > \pi_4^{(E)} \Rightarrow \frac{(a_M + a_T)k}{2} - \frac{kqc_j}{2} > (a_T)k$$
$$a_M - a_T - qc_j > 0 \tag{39}$$

that is always verified.

C Appendix

In the equilibrium with corruption (equilibrium C), the entrepreneur's profit is:

$$\Pi_E^C = \left(\frac{a_M + a_T}{2}\right) k - \frac{c_j kq}{2} \tag{40}$$

thus the constraint is:

$$\overset{\bullet}{k} = \left(\frac{a_M + a_T}{2}\right) k - \frac{c_j kq}{2} - C \tag{41}$$

The Hamiltonian function $H(C, k, \lambda)$ is :

$$H = e^{-\rho t}\frac{C^{1-\sigma} - 1}{1-\sigma} + \lambda \left[\left(\frac{a_M + a_T}{2}\right) k - \frac{c_j kq}{2} - C\right] \tag{42}$$

where λ is a costate variable. Optimization provides the following first-order conditions:

$$\frac{\partial H(C, k, \lambda)}{\partial C} = e^{-\rho t} C^{-\sigma} - \lambda = 0 \tag{43}$$

and

$$-\frac{\partial H(C, k, \lambda)}{\partial \lambda} = \overset{\bullet}{\lambda} \Rightarrow -\lambda \left[\frac{a_M + a_T}{2} - \frac{qc_j}{2}\right] = \overset{\bullet}{\lambda} \tag{44}$$

By deriving the first condition, the consumption growth rate is obtained:

$$\gamma_j^C = \frac{1}{\sigma}\left[\frac{a_M + a_T}{2} - \frac{qc_j}{2} - \rho\right] \tag{45}$$

In equilibrium NC, the entrepreneur's profit is:

$$\Pi_E^{NC} = a_M k \tag{46}$$

thus the constraint is:

$$\overset{\bullet}{k} = a_M k - C \tag{47}$$

The Hamiltonian function $H(C, k, \lambda)$ is :

$$H = e^{-\rho t}\frac{C^{1-\sigma} - 1}{1-\sigma} + \lambda[a_M k - C] \tag{48}$$

A straightforward computation gives the following expression for the constant consumption growth rate:

$$\gamma^{NC} = \frac{1}{\sigma}[a_M - \rho] \tag{49}$$

D Appendix

At a steady state, everything grows at the same rate and therefore $\frac{\overset{\bullet}{k}}{k}$ is constant. At equilibrium C we know that

$$\frac{\overset{\bullet}{k}}{k} = (\frac{a_M + a_T}{2}) - \frac{qc}{2} - \frac{C}{k}.$$

Since $\frac{\overset{\bullet}{k}}{k}$ is constant, then the difference between both terms on the right should also be constant, and because a_M, a_T, c and q are constant, then C and k should grow at the same rate. Similarly, since $y = a_M k$, at a steady state income grows at the same rate as capital. The same applies in the case of equilibrium NC.

E Appendix

$M : [0, +\infty) \to [0, +\infty)$ is an Orlicz function if and only if it is continuous, convex and nondecreasing in $[0, +\infty)$, $M(0) = 0$, $M(x) > 0$ for $x > 0$ and $\lim_{x \to +\infty} M(x) = +\infty$. Krasnoselskii and Rutitsky (1961) proved a representation theorem, stating that given an Orlicz function M, there exists a function $h : [0, +\infty) \to [0, +\infty)$ such that

$$M(x) = \int_0^x h(t)dt$$

and $h(t)$ is right-differentiable for $t \geq 0$, $h(0) = 0$, $h(t) > 0$ for $t > 0$, h is non-decreasing and $\lim_{t \to +\infty} h(t) = +\infty$. h is known as the kernel of the Orlicz function M.

F Appendix

Define the function $q^* : [0, +\infty) \to \mathbf{R}$ such that

$$q^*(x) = h^{-1}\left(\frac{\alpha}{g(x)}\right) \cdot \left(1 - \frac{1}{x}\right). \tag{50}$$

The first order condition is

$$(q^*)'(x) = \frac{1}{h'(\alpha/g(x))} \cdot \frac{-\alpha g'(x)}{g^2(x)} \cdot \left(1 - \frac{1}{x}\right) + h^{-1}\left(\frac{\alpha}{g(x)}\right) \cdot \frac{1}{x^2} = 0.$$

Then

$$\frac{1}{h'(\alpha/g(x))} \cdot \frac{1}{h^{-1}(\alpha/g(x))} \cdot \frac{-\alpha g'(x)}{g^2(x)} = \frac{1}{x(x-1)}.$$

By integrating, we obtain

$$log(h^{-1}(\alpha/g(x))) = log\left(\frac{x}{K(x-1)}\right), \qquad K \in \mathbf{R}^+.$$

A straightforward computation then gives

$$\exists (q^*)'(x^*) = 0 \Leftrightarrow g(x^*) = \alpha h\left(\frac{x^*}{K(x^*-1)}\right).$$

Returning to the discrete variable n, and imposing the boundary condition $g(2) = g_2$, we have that $g(n^*)$ can be written as in (30), with K given by (31) and

$$n^* \in \{[x^*], [x^*]+1\} \,|\, q(n^*) = \max\{q([x^*]), q([x^*]+1)\}.$$

By hypothesis (32), we have that n^* is the unique absolute maximum point for q^*.
The optimal growth rate γ^* can be written as $\gamma^*(n) := \gamma(q^*(n))$. Directly by formula (28), we observe that a straightforward computation gives that γ^* has the same behavior of q^*, i.e. it has a unique maximum point in n^* as well.
The costs at the optimal monitoring level m^* are:

$$(c^\circ)^*(n) = \frac{(a_M - a_T)}{q^*(n)}.$$

Therefore

$$((c^\circ)^*)'(n) = -\frac{(a_M - a_T)}{(q^*)^2(n)} \cdot (q^*)'(n). \tag{51}$$

The coefficient of $(q^*)'(n)$ in (51) is negative, and so n^* is the unique minimum point for $(c^\circ)^*$.

References

[1] Alesina, A.,Baqir,R., Easterly, W., 1999. Public Goods and Ethnic Divisions. Quarterly Journal of Economics 114(4), 1243-1284.

[2] Alesina, A., Devlseschawuer,A., Easterly, W., Kurlat, S., Wacziarg, R.,2003. Fractionalization. Journal of Economic Growth 8(2), 155-94.

[3] Alesina, A., La Ferrara, E., 2002. Who Trusts Others? Journal of Public Economics 85(2), 207-34.

[4] Atlas Narodov Mira, 1964. Moscow: Glavnoe upravlenie geodezii i cartografii.

[5] Barreto, R., 2000. Endogenous Corruption in a Neoclassical Growth Model. European Economic Review, 35-60.

[6] Barro, R.J., 1991. Economic Growth in a Cross Section of Countries. Quarterly Journal of Economics 106, 407-444.

[7] Collier, P., 2000. Ethnicity, Politics and Economic Performance. Economics and Politics 12(3), 225-45.

[8] Collier, P., 2001. Implications of Ethnic Diversity. Economic Policy 32(16), 127-66.

[9] Easterly, W., Levine, R., 1997. Africa's Growth Tragedy: Policies and Ethnic Divisions. Quarterly Journal of Economics 112(4), 1203-1250.

[10] Fearon, D.J., 2003. Ethnic and Cultural Diversity by Country. Journal of Economic Growth 8, 195-222.

[11] Glaeser, E. L., La Porta,R., Lopez-De-Silanes, F., Shleifer, A., 2004. Do Institutions Cause Growth? Journal of Economic Growth 9, 271-303.

[12] Jain, A., 2000. Corruption: a Review. Journal of Economic Surveys 1, 71-121.

[13] Krasnoselskii, M.A., Rutitsky, Y.B., 1961. Convex Function and Orlicz Spaces, Groeningen, Netherlands.

[14] La Porta, R., Lopes de Silanes F., Shleifer A., Vishny R., 1998. The Quality of Government. Journal of Law, Economics and Organization 15(1), 222-79.

[15] Li, H., Xu C.L., Zou H., 2000. Corruption, Income Distribution and Growth. Economics and Politics, 155-182.

[16] Mauro, P., 1995. Corruption and Growth. Quarterly Journal of Economics, 681-712.

[17] Rose - Ackerman, S., 1975. The Economics of Corruption. Journal of Public Economics, 187-203.

[18] Rose - Ackerman, S., 1978. Corruption, A Study in Political Economy. Academic Press.

[19] Rose - Ackerman, S., 1999. Corruption and Government. Cambridge: Cambridge University Press.

[20] Shleifer, A., Vishny, R., 1993. Corruption. The Quarterly Journal of Economics, 599-617.

[21] Tajfel, H., Billig, M., Bundy, R.P., Flament, C., 1971. Social Categorization and Intergroup Behavior. European Journal of Social Psychology 1, 149-178.

[22] Tanzi, V., 1994. Corruption, Governmental Activities and Markets. IMF Working Paper, WP/94/99.

[23] Tanzi, V., 2000. Policies, Institutions and the Dark Side of Economics. Cheltenham, Edward Elgar.

[24] Weber, M., 1978. Economy and Society. Berkeley: University of California Press.